# Chapter A14: Discounting Benefits

## Introduction

Discounting refers to the economic conversion of future benefits and costs to their present values, accounting for the fact that individuals tend to value future outcomes less than comparable near-term outcomes. Discounting is important when benefits and costs occur in different years, and enables a comparison of benefits to costs across time periods.

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For the section 316(b) Phase II rule, the need to discount arises from two sources. First, there will be a delay between the time the rule is enacted and the time facilities attain compliance and begin to reduce impingement and entrainment (I&E) impacts. Second, some fish saved today will require one or more years to grow to a size at which anglers will harvest them. The discounting methods EPA has applied to address both of these issues are discussed in the following sections.

## A14-1 Discounting to Account for the Time it Takes to Enact New Technologies

Under the section 316(b) Phase II rule, facilities will not achieve compliance immediately. Facilities will face costs once the rule takes effect, but it will take time to make the required changes. EPA has assumed that it will take one year from the start of the rule for facilities to reach compliance. Thus all recreational, commercial, and non-use benefits are discounted one year using two discount rates. A real discount rate of 3 percent is applied as a reasonable estimate of the social rate of time preference. Results assuming a real discount rate of 7 percent are also reported as an alternative, in accordance with OMB guidance to reflect the estimated opportunity cost of capital.

## A14-2 Discounting to Account for the Time it Takes Fish Spared I&E to Grow to Harvestable Age

The issue of time lags between implementation of best technology available (BTA) and resulting increased fishery yields stems from the fact that one or more years may pass between the time an organism is spared impingement or entrainment (I&E) and the time of its ultimate harvest. For example, a larval fish spared entrainment (in effect, at age 0) may be caught by a recreational angler at age 3, meaning that a 3-year time lag arises between the incurred cost of BTA and the realization of the estimated recreational benefit. Likewise, if a 1 year old fish is spared impingement and is then harvested by a commercial waterman at age 2, there is a 1-year lag between the incurred BTA cost and the subsequent commercial fishery benefit. In this analysis, EPA applied discounting by species groups in each regional study, as described below.

### A14-2.1 Discounting Recreational and Commercial Fishing Benefits

To discount recreational and commercial fishing benefits, EPA collected species specific information on ages of fish at harvest to estimate the average time required for an age-1 equivalent fish to reach a harvestable age. EPA then discounted these results using two discount rates: a real rate of 3 percent is applied as a reasonable estimate of the social rate of time preference, and a real rate of 7 percent is also used.

The key factor in the analysis is the range of ages at which different types of fish are typically landed by commercial or recreational anglers. These results are species specific; they account for the life history of each species (i.e., the percent harvested in each year class, and weight attained in each year). For each species, EPA's model uses fishery data that indicate what percentage of the impacted fish will survive to a given age. Then, for each cohort of fish that survives to a given age (for each species), EPA applies a suitable fishery mortality estimate that indicates how many of that cohort will be harvested. The detailed methods are presented in Chapter A5.

As an example of how the discounting works, assume for a given fish species, X, killed in a larval stage (i.e., at age 0), that 3 percent of the surviving fish typically are landed at age 1, and 15 percent at age 2. Thus, 3 percent of the surviving fish of species X would have their landed values discounted over a 1 year period for entrainment (since once spared mortality from entrainment, it takes 1 year until they are landed and the benefit is "realized"). Also, 15 percent of the fish in this entrainment example for species X would have their associated landed values discounted for 2 years. Then, the present values are summed across the cohort of base year entrainment survivors for species X to give the present value of the stream of commercial (or recreational) landings associated with implementing BTA in the base year. In this example, with a 3 percent discount rate, if 1,000 fish are saved today at age 0, then an estimated 3 percent, or 30, would be caught next year. If the benefit for each fish is $1 today, the total benefit would be $30 now, while the discounted benefit 1 year in the future would be $29.10. Similarly, an estimated 15 percent, or 150 fish, would be caught in year 2, which at $1 per fish would have benefits of $150, but when discounted would have benefits of $141.10. The total benefit of saved fish that are eventually harvested is $180 with no discounting, which equals $170.20 when discounted at 3 percent. Thus, the discounted benefits in this example are equal to 0.95 the undiscounted benefits ($170.20/$180.00).

The discounted values vary depending on the life history of each fish species affected. Fish that tend to be harvested at young ages will have relatively short time lags between implementation of BTA and the subsequent timing of changes in landings. In contrast, long-lived fish that tend to be caught at relatively older ages will tend to have longer time lags (and, hence, they will have larger impacts from discounting and lower present values).

The discounted results also vary between commercial and recreational landings, because the former is based on weight of landings whereas the latter is based on number of fish landed. Results also vary between I&E, because impacts from the former are reflected as adult fish with age distributions that vary by species whereas entrainment impacts are predominantly on eggs and larvae (age 0).

To calculate the discounted impacts, EPA compiled data on the time stream of landed fish (and associated fish mass) and applied alternative discount rates (3 percent and 7 percent) to calculate the present value stream of landings from a given year's I&E impacts. An illustrative summary is provided in Tables A14-1 (3 percent discount rate) and A14-2 (7 percent discount rate) for three generalized classes of fish ranging from relatively long-lived fish (e.g., striped bass, pollack) to short-lived species that tend to be harvested by or at age 1 (e.g., pink shrimp).

In brief, at a 3 percent discount rate, the present value benefits will be at about 90 percent to 95 percent of the undiscounted estimate (i.e., between 5 percent to 10 percent less than stated at proposal) for most of the fish with mid-range life/harvest histories (e.g., walleye). For longer-lived species, the present values will tend to be lower (e.g., 80 percent to 91 percent), and for shorter-lived species, the present values will tend to be higher (with discounted values between 96 percent and 100 percent of undiscounted results).

EPA recognizes that addressing species groups rather than individual species means that potentially important species-specific differences cannot be accounted for. However, the lack of life history data, fishing mortality rates, and other information necessary to calculate foregone yield and other endpoints of interest at the regional and national level rather than at the facility specific level makes it necessary to group species in this way.

The results of these discounting methods were applied in the commercial and recreational benefits analyses for each region. The discount factors used by species are reported in the I&E chapter for each region (B2, C2, etc.).

**Table A14-1**
**Examples of Discounted Losses as a Percentage of Undiscounted Losses**
**3% Rate of Discount**

| Species Group | Entrainment | | Impingement | |
|---|---|---|---|---|
| | Commercial | Recreation | Commercial | Recreation |
| Low (long-lived species, e.g., pollack, striped bass) | 0.83 | 0.88 | 0.86 | 0.91 |
| Midrange (walleye, crappie) | 0.90 | 0.93 | 0.92 | 0.95 |
| High (short-lived species, e.g., silverside, pink shrimp) | 0.96 | 0.97 | 1.0 | 1.0 |

**Table A14-2**
**Examples of Discounted Losses as a Percentage of Undiscounted Losses**
**7% Rate of Discount**

| Species Group | Entrainment | | Impingement | |
|---|---|---|---|---|
| | Commercial | Recreation | Commercial | Recreation |
| Low (long-lived species, e.g., pollack, striped bass) | 0.66 | 0.75 | 0.71 | 0.80 |
| Midrange (walleye, crappie) | 0.78 | 0.84 | 0.83 | 0.90 |
| High (short-lived species, e.g., silverside, pink shrimp) | 0.93 | 0.93 | 1.0 | 1.0 |

## A14-2.2 Discounting Non-use Benefits

EPA assumes that non-use benefits from reductions in I&E would begin to accrue to the affected populations after technology installation is completed because non-use benefits are not associated with fish size or weight. Therefore, baseline non-use values are not discounted in analyses of non-use benefits.